Desktop

Thermally Advantaged Chassis: The Smart Choice for Systems Based on High-End Processors

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Overview

Historically, system integrators selecting a chassis for personal computers did not consider thermal management their key criterion. Instead, they tended to use the generic “beige box” solution. Things have changed, however, with the dramatic increase in processor and system performance and corollary increase in the heat generated by the processor and subsystem components. To address the resulting thermal-management challenge, processor designers began adding passive heatsinks in the early 1990s and active heatsinks in more recent years, system designers incorporated fans to improve air flow inside the system, and chassis designers have begun incorporating major thermal-management enhancements into their products. For system integrators, these enhancements are edging out the “beige box” solution as the deciding criterion when it comes to chassis selection. In this article, you will learn more about the technical foundation of such enhancements.

Determining thermal requirements

For reliability, processor manufacturers specify a maximum component temperature, directly related to the thermal design power of the processor. Meeting this specification is the job of thermal-management solutions such as heatsinks and system fans designed to lower the ambient temperatures surrounding the processor. Assuming the maximum component temperature is case temperature, or the temperature at the geometric center of the integrated heat spreader, the following equation describes the relationship between the factors that influence the thermal management of the system.

$TDP \times \Psi CA = TC - TA$ (equation 1)

Where:

TDP is thermal design power (W),

ΨCA is the thermal resistance of the heatsink and thermal interface material (°C/W),

TC is the case temperature of the processor (°C), and

TA is the average ambient air temperature local to the processor (°C).

System integrators have little control over thermal design power and case temperature because they are dictated by the processor manufacturer. This leaves a choice of two options for meeting TC requirements: using more efficient thermal solutions (heatsinks and/or thermal-interface materials) or reducing the processor ambient temperature. Using more efficient thermal solutions may seem to be the more attractive option, but there is a catch. Manufacturers of processor heatsinks have increased the efficiency of these components significantly over the past 10 years, with currently available solutions (including thermal-interface material) featuring thermal resistances on the order of 0.33°C/W. This means that without significant innovations, heatsink solutions using air cooling are reaching their technology limits.

So what about the second option, reducing the processor ambient temperature? This option is particularly attractive because, as shown in equation 1, a reduction in ambient temperature will accommodate an increase in thermal design power. This is essential to an increase in processor performance, which is typically accompanied by an increase in thermal design power.

Historically, the processor ambient temperature has been defined as 42°C–45°C. Assuming an external system ambient temperature of 35°C, this indicates a 7°C–10°C rise. This rise, or pre-heat of air, is typically caused by heat that is generated by the chipset, graphics card, memory, voltage regulator, peripherals, and other heat-generating subsystem components. Yet such a rise, perfectly acceptable in today’s processors and systems, will not be tolerated in those of the future.

The Intel initiative

For this reason, processor and system designers at Intel have defined 38°C as the ideal maximum processor ambient temperature. Assuming the traditional 35°C external system ambient temperature, this requirement limits the maximum temperature rise surrounding the processor to 3°C. To help ensure that new chassis designs meet this requirement, Intel has launched a program with leading chassis manufacturers working on what have come to be known as thermally advantaged components and techniques, and has developed a number of publications on how these components and techniques are implemented and on their benefits.

For example, one publication describes how chassis manufacturers are using ducting to direct fresh air to the processor. Another points out how a thermally advantaged chassis can help designers lower the RPM, and consequently the noise level, of system fans. These are just two examples of the projects now being undertaken by chassis manufacturers seeking to meet a maximum processor ambient temperature of 38°C.

Summary

System integrators seeking to take full advantage of the additional power and performance of next-generation processors must make thermal management a priority by selecting a chassis that meets the most stringent maximum processor ambient temperature. Today, that is being defined as 38°C, representing just a 3°C rise over the commonly accepted external ambient temperature of 35°C. Chassis that meet such a specification will need to be designed with what are known as thermally advantaged components and techniques as described in publications of the Intel Thermally Advantaged Chassis Program and demonstrated at Comdex. Integrators incorporating thermally advantaged chassis into their systems will find this approach to be the most cost-effective way of adopting next-generation processing power.

For more information

For the currently available publications on thermally advantaged components and techniques in chassis design and development, visit the Desktop Form Factors Web site (http://www.formfactors.org). For a complete list of manufacturers implementing thermally advantaged components and techniques, visit http://program.intel.com.

Author bio

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